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Materiel Test Procedure 6-2-516
Electronic Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

ADEQUACY OF SHELTER AND VAN MOUNTED LIGHTING, VENTILATION, AIR CONDITIONING AND HEATING EQUIPMENT

1. OBJECTIVE

The objective of this Materiel Test Procedure is to determine the adequacy of shelter and van mounted lighting, ventilation, air conditioning and heating equipment.

2. BACKGROUND

The background demand for rapid mobility in modern warfare has resulted in the development of a series of standardized transportable shelters and mobile van type enclosures designed for mounting a wide variety of military equipment. Such shelters, when used for installation of assemblages of communications, surveillance, and avionic electronic equipment, require more meticulous attention to the problems of lighting, ventilation, air conditioning and heating than is the case when used for housing equipment less sensitive to these environmental conditions. Ideally, electronic installations in these enclosures are capable of satisfactory operation in any climate. However, engineering tests and routine operation of assemblages mounted in shelters and vans have disclosed a generally unsatisfactory condition in that the heating, ventilating, and air conditioning equipment frequently could not maintain acceptable interior air temperatures and air circulation even under normal variations of weather encountered in temperate zones. These inadequacies are manifested in electronic equipment failures; excessive size, weight, and power consumption of heating and cooling equipment; high noise levels; and heating, cooling, and ventilation inadequate for the safety, efficiency, and comfort of operating personnel.

The tests outlined in this materiel test procedure will determine the degree to which the overall system of lighting, ventilation, air conditioning and heating provided in shelters and vans meets the operating requirements, the Technical Characteristics, the Qualitative Materiel Requirement (QMR), or other applicable specifications.

3. REQUIRED EQUIPMENT

a. Illumination meter
b. Thermometers, Mercury type and Alcohol type
c. Anemometer, Deflecting vane type
d. Psychrometer, Aspirated type or Sling type
e. Thermocouples
f. Recording Potentiometer (three channels minimum)

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g. Noise analyzer, Octave band (see Appendix B for specification)
h. Extreme Temperature Environmental Chambers
* i. Psychrometer, Thermocouple type
* j. Hygrometer, Orgainic
* k. Resistance Thermometer
* l. Thermal anemometer
* m. Kata thermometer
* n. Smoke Candles, Smoke Tubes, or Smoke Bombs
* o. Stop watch
p. Hydro Carbon Analyzer
q. Smoke source

* Optional

4. REFERENCES

A. John O. Kroehenbuehl, Electric Illumination, John Wiley and Sons, Inc., 2nd edition, 1951.
B. Matthew Luckiesh, Light, Vision and Seeing, D. Van Nostrand Company, Inc., 1944.
C. Luckiesh and Moss, The Science of Seeing, D. Van Nostrand Company, Inc., 1948.
D. ASHRAE Guide and Data Book, Fundamentals and Equipment, American Society of Heating, Refrigerating and Air Conditioning Engineers, 1963.
E. Heating, Ventilating and Air Conditioning Guide, American Society of Heating, Refrigeration and Air Conditioning Engineers, 1960.
F. Strock and Koral, Handbook of Heating, Ventilating, and Air Conditioning, The Industrial Press, 1965.
G. Human Engineering Guide to Equipment Design, Sponsored by Joint Army-Navy-Air Force Steering Committee, McGraw-Hill Book Company, Inc., 1963.
H. AR 705-15, Operation of Materiel Under Extreme Conditions of Environment.
I. USATECOM Project No. 6-5-0611-01, Special Study of Heating and Cooling Systems of Van and Shelter Inclosed Electronic Equipment.
J. MIL-STD-810A, Environmental Test Methods for Aerospace and Ground Equipment.
K. SCL-1280D, Design of Electronic Equipment for: and Systems Installation in Shelters and Vans.
L. MTP 6-2-510, Environmental Chamber Tests

5. SCOPE

5.1 SUMMARY

This Materiel Test Procedure describes a method for testing the adequacy of shelter or van mounted lighting, ventilation, air conditioning and heating equipment while functioning individually or as an integrated system.

5.1.1 Equipment Tests

The equipment tests contained herein are designed to allow the determination of the adequacy of specific items of equipment as described below:

a. Lighting Equipment Test - The objective of this test is to determine the characteristics of general and supplemental lighting in terms of intensity, quality, brightness contract and freedom from objectionable shadows and glare.

b. Ventilation Equipment Test - The objective of this test is to determine the volume of fresh air supplied, the rate of air movement, the pattern of air flow and the rate capability of the air exhaust equipment within the enclosure.

c. Heating and Air Conditioning Equipment Test - The objective of this test is to determine the capability of the system to maintain suitable levels of effective temperature (ET) within the enclosure during typical climatic conditions in temperate zones.

5.1.2 System Tests

The system tests are designed to facilitate a determination of the adequacy of shelter or van mounted lighting, ventilation, heating and air-conditioning equipment while functioning as an integrated system. Specific system tests to be conducted are as follows:

a. System Design Test - The objective of this test is to determine the functional design characteristics of the ventilating, heating, and air conditioning equipment and the capability of operating as an integrated system.

b. System Noise Level Test - The objective of this test is to determine if the noise generated by the ventilating, heating, and air conditioning equipment is within acceptable levels.

c. Environmental Extremes - The objective of this test is to determine the capability of the system to attain within a reasonable reaction time and then to maintain suitable levels of effective temperature within the enclosure under extremes of ambient heat and cold.

5.2 LIMITATIONS

The environmental chamber tests required by this MTP are limited to those bearing on the adequacy of the ventilating, heating, and air conditioning system to maintain acceptable ambient air conditions in the enclosure Environmental chamber tests of electronic equipment and the shelter or van which may be required by the commodity engineering test procedure are excluded. However, the test procedures herein are designed to be inserted in proper sequence with such other tests normally performed during the cycling of the environmental chamber for testing of assemblages installed in shelters and vans.

Specially designed lighting systems, such as those required for certain types of radar CRT displays, are not included in this procedure. Such systems must be tested under specifications peculiar to the type of lighting used.

6. PROCEDURES

6.1 PREPARATIONS FOR TEST

6.1.1 Pre-Test Preparations

6.1.1.1 General Preparations

a. Personnel responsible for conducting the test should ensure that applicable instructions and design specifications are available.

b. Reports of previous tests should be available when appropriate.

c. Operating instructions for test instruments to be used in the conduct of the test should be obtained and available to test personnel.

d. A test log book or folder should be prepared and utilized to record data during tests.

e. Availability of the Environmental Chamber facilities should be checked and firm scheduling verified.

f. Ensure that all test instruments have been calibrated to within desired tolerances.

g. Test personnel should be briefed prior to testing on the purpose of the test and the degree of accuracy expected.

6.1.1.2 Preparations For Lighting Tests

a. Refer to Appendix A for technical information and general instructions applicable to this test.

b. Test all luminaires, lights, switches and fuse or circuit breaker systems to ensure proper mechanical and electrical condition. Replace any defective units or parts.

c. Note and record the type of lighting, (incandescent, flourescent, or combination), both general and supplementary.

NOTE: General lighting equipment is considered to be that lighting equipment installed or fixed in permanent locations within the van or shelter, supplementary lighting equipment is considered to be that lighting equipment within the shelter or van capable of being moved or directed to various locations in order to reinforce existing fixed lighting equipment or to provide lumination in situations not adequately provided for by general lighting equipment.

d. Note and record the method of light distribution, (Direct, indirect diffused or combination).

e. Note and record the type and location of luminaires for general and supplemental lighting. Indicate whether or not the position of supplemental lighting is adjustable and record the limits of adjustment if applicable.

f. Note and record location and size of doors, windows and skylights which may be used for natural illumination.

g. Prepare forms for recording data.

h. Check operation and calibration of illumination meter(s).

6.1.1.3 Preparations for Ventilation, Heating and Air Conditioning Tests

a. Refer to Appendix B for Technical information and general instructions applicable to this test.

b. Note and record the following:

1) Description of the test item:

a) Nomenclature, type, manufacturer, model and serial number of all components to include the van or shelter and the equipment to be tested.
b) Design capacity (BTU or CFM) of the tested equipment.

2) Power requirements of each component of the ventilating, heating, and air conditioning system. Include voltage and frequency requirements, starting and running power factor and power consumption, phase (single or polyphase), delta or wye, and whether 2, 3, or 4 wire.
3) Note and record number, size, location and type grid of air intake and exhaust ports, and means provided for opening and closing.
4) Make a general inspection and operational test of all components of the system to ensure satisfactory operating condition and readiness for test.
5) Prepare forms for recording test data.
6) Check operation and calibration of test instruments.

c. Prior to making tests involving measurement of ventilation temperature, and humidity in the shelter or van, the following data shall be obtained and recorded:

1) Outside dry-bulb and wet-bulb temperatures, (relative humidity) and wind speed and direction.
2) Other weather conditions such as sunny, overcast, partly cloudy, rain, snow etc.

d. The above data shall be recorded on an hourly or other periodic basis as required by the test schedule.

e. The weather data shall be recorded on a suitable form such as the sample test data sheet, Appendix C.

6.1.2 Pre-Test Conditions

6.1.2.1 Pre-Test Conditions For Ventilation Tests

a. This test shall be performed during a period of average weather conditions at the test site (preferred temperature 77°F ± 5°F, humidity 50% ± 5%). Similar tests shall be performed under the ambient temperature extremes stated in paragraph 6.2.2.3.

b. All doors, windows, and other openings except ventilating ports appropriate for the mode of operation shall be closed for this test. Operating personnel shall not be present.

6.1.2.2 Pretest Conditions for Heating and Air Conditioning Tests

a. These tests shall be performed during a heating cycle and an air conditioning cycle and shall be coordinated with the ventilation tests. A sufficient variety of thermostat and other control settings shall be tested to allow for a thorough analysis of their adequacy, accuracy, placement and use.

b. The tests shall be conducted during appropriate periods of the widest temperature extremes likely to be encountered at the test site during conduct of the commodity test. Similar tests shall be performed under the ambient temperature extremes stated in paragraph 6.2.2.6.

c. All doors, windows, and other openings except ventilating ports appropriate for the mode of operation shall be closed. The installed equipment assemblage shall be in the operating condition. The required number of operating personnel must be present as these people will influence the systems as they will actually perform in a real condition.

d. Tests shall be made only after the temperature of all operating equipment and the interior of the enclosure has stabilized. However, as a part of this test the enclosure stabilization time shall also be measured and recorded. Measurements shall be continued over a sufficient period of time to assure that additional readings would not change the average.

e. Either non-recording or recording type instruments may be used. Instrument sensors shall be shielded from radiation sources and sinks which are sufficiently warmer or colder than the ambient air to cause a subjective change in thermal comfort of personnel. Such sources, if present, shall be identified and noted with appropriate comment.

f. Measurements shall not be made in front of any intake duct port where the direct impingement of conditioned air could affect the readings.

6.2 TEST CONDUCT

6.2.1 Equipment Tests

6.2.1.1 Lighting Equipment Tests

6.2.1.1.1 General Lighting

a. Prepare a grid pattern of the interior of the shelter or van, representative of a horizontal surface located at a height of 30 inches above the floor level. (Grid scale shall be 1 inch for every 12 to 18 inches). Thereon, indicate locations of all luminaires provided for general lighting. The scale to

be used shall be governed by the size and configuration of the enclosure and installed equipment.

b. All lights provided for general lighting shall be switched on. Supplementary lights shall be off.

c. Make foot-candle measurements of the light level at a height of 30 inches (desk level) above the floor at all intersecting points of the grid not obstructed by installed equipment. Take additional readings as necessary if there are indications that doing so will significantly change the average.

d. Make foot-candle measurements of the general illumination level at 3 to 6 inch intervals at all regular work position surfaces such as desks, tables, and equipment operating positions. Enter the readings on scaled grid patterns representative of the work surface area. The interval and scale used shall be governed by the area and configuration of the work surface.

e. Make additional foot-candle measurements in obscure areas and at equipment surfaces not included in previous tests where occasional inspections, tests, and adjustments must be made. Indicate these locations and enter measurement data on a floor plan or equipment layout sketch, as appropriate.

f. Repeat procedures b through e above with all electronics equipment, ventilating and heating air conditioning system equipment in simultaneous operation.

6.2.1.1.2 Supplementary Lighting Equipment

a. All general and supplementary lights shall be on for this test. The work position under measurement shall be occupied. Adjustable luminaires shall be positioned for optimum visibility of the work surfaces as judged by the individual performing the tests.

b. Make foot-candle measurements of the total general and supplemental illumination level at 3 to 6 inch intervals at the surfaces of all work positions equipped with supplemental lighting such as desks, tables, and equipment operating positions. Enter the readings on scaled grid patterns representative of the work surface area. The intervals of measurement shall be governed by the area and configuration of the work surface.

c. Repeat procedures a and b above, with all electronics, ventilating and heating - air conditioning system equipment in simultaneous operation.

6.2.1.1.3 Surrounding Reflectance and Brightness

a. All general and supplementary lights shall be on for this test.

b. This test shall be made at all regular work positions.

c. With the illumination meter held at levels and positions normal for the eyes of the occupant of the work position, take a series of representative foot-candle readings in the directions of all work surfaces within the normal fields of vision of the occupant when performing his tasks. (The normal field of vision is considered to include 30 degrees to the sides of the center of the visual field). Take additional representative readings to encompass a field 90 degrees laterally and 30 degrees vertically of normal eye positions of the occupant. These readings will provide data for comparison of work surface and surrounding reflectance factors and brightness.

6.2.1.1.4 Glare

a. All general and supplementary lights shall be on for this test. Adjustable luminaires shall be positioned for optimum visibility of work surfaces.

b. Observations for indications of direct and specular glare shall be made from all regular work positions, positions where occasional inspections, tests, and adjustments are made, and at randomly selected points throughout the enclosure. Foot-candle measurements of observed glare shall be made to determine whether acceptable limits are met.

6.2.1.1.5 Shadow

a. All general and supplementary lights shall be on for this test. Adjustable luminaires shall be positioned for optimum visibility of work surfaces. The work position under test and adjacent work positions shall be occupied.

b. Observations to detect the presence of objectionable shadows shall be made throughout the enclosure, at all regular work positions, and at positions where occasional inspections, tests, and adjustments are made. (It should be recognized that some degree of relatively unobjectionable shadow which is impracticable to eliminate will often be present during some operations.)

6.2.1.1.6 Brightness Contrast

a. All general and supplementary lights shall be on for this test. Adjustable luminaires shall be positioned for optimum visibility of work surfaces.

b. This test shall be subjective in nature, since it is impracticable to make foot-candle reflectance readings that will indicate reflectance factors of background relative to small objects which must be observed, read, and manipulated, e.g. meters, dials, switches, keys and adjusting screws.

c. The test shall comprise the observations and comments of all operating, maintenance, and test personnel concerning the visibility of equipment features requiring reading, manipulation, adjustment and routine maintenance. These observations shall be made and recorded throughout the period of the commodity test.

6.2.1.1.7 Natural Lighting

It is not expected that all electronic assemblages in shelters and vans can be operated efficiently with only natural lighting. However, it is required that tests be made to determine the extent of operations which can be conducted without artificial light, particularly during the reestablishment of operations after displacement. It is further required that the feasibility of operating with a mixture of natural and artificial light be determined.

b. With the shelter or van and equipment assemblage in the configuration ready for displacement, it shall be made ready for operation without the use of artificial light. The test shall be conducted under various conditions of daylight including full sunlight, overcast, and twilight.

c. Under daylight conditions as in b., above, full operations shall be conducted to the extent possible under natural lighting from windows, doors, and skylights. Similar tests shall be made with a selective mixture of natural

and artificial lighting.

6.2.1.1.8 Light Tightness

a. Tests shall be made to determine if blackout provisions prevent the escape of light from the shelter or van. The tests shall be made on a dark moonless night.

b. Place the van or shelter as far away as practicable from any source of interfering lights and in a position in which no direct artificial lights can be seen.

c. With the shelter or van prepared for blackout and all interior lights on, view possible sources of light leaks from every possible angle. Make this check at distances varying from a few feet to several hundred meters.

d. Check automatic door switches for proper operation and to determine if both general and supplementary lights are extinguished when the door is opened. Check the lockout devices on doors to determine whether they can be made non-operational when blackout conditions are not required.

6.2.1.2 Ventilation Equipment

6.2.1.2.1 Air Velocity at Outlets

a. Turn on all ventilating equipment within the shelter or van, and and maintain controls in the ventilate position.

b. With a suitable anemometer and probe as described in Appendix B., make traverse measurements of air velocity at each ventilation duct or outlet.

c. Record air velocity measured in feet per minute.

NOTE: 1) When deflecting grills are present, the probe used in making velocity measurements should be turned to the angle giving the maximum reading.

NOTE: 2) For measurements at round duct outlets, a minimum of 20 readings should be taken along two diameters at centers of equal annular areas as shown in Figure B-2, Appendix B, Page B-8. For rectangular ducts, a minimum of 16 readings should be taken at the centers of equal areas over the cross section of the duct outlet as shown in Figure B-3, Appendix B, Pg. B-9.

d. Repeat procedures a through c above with all electronics, lighting, and heating - air conditioning system equipment on to determine if simultaneous operation, drawing from a common power source, appreciably affects ventilation measurements.

6.2.1.2.2 Air Movement

a. Turn on ventilating equipment within the van or shelter and maintain controls in the ventilate position.

b. Using a suitable anemometer and probe as described in Appendix B, make measurements or air velocity at mid-level grid points with intervals of one or two feet depending on the size of the enclosure.

NOTE: Measurements shall extend to within four inches of side and end walls or installed equipment surfaces. Readings shall be those of the greatest velocity regardless of direction of flow.

c. Repeat measurements of air velocity in each of three equal sections of the enclosure (front, center and rear).

d. Repeat procedures a through c above, as indicated in 6.2.1.2.1 d.

e. Perform procedures a through c above during a heating cycle and an air conditioning cycle.

6.2.1.2.3 Air Exhaust

a. Position a smoke source (smoke grenade or pot) at the center of the van or shelter and ignite.

NOTE: Prior to ignition, the enclosure should be closed or sealed and all equipment within should be off.

b. Allow sufficient time to elapse for the smoke to become uniformly dispersed within the enclosure.

c. Measure with the hydrocarbon analyzer, the concentration of smoke at the center of the enclosure.

d. Turn on the ventilation- exhaust system equipment and repeat measurement made in b above, at 30 second intervals for a total time of ten minutes or until smoke concentration falls to an undetectable level, whichever occurs first.

e. Record all smoke concentration measurements and the total time interval during which measuring occurred.

6.2.1.3 Heating and Air Conditioning Equipment Test

6.2.1.3.1 Temperature and Humidity

a. Close all doors, windows, and other openings except ventilating ports appropriate for the particular operating mode being tested.

b. Turn on heating equipment and record thermostat setting, and time heating equipment is initially turned on.

c. Allow sufficient time for the temperature inside the enclosure to reach a steady or stable state, and record time stabilization.

d. Measure and record with a suitable psychrometer, the dry-bulb and wet-bulb temperatures at mid-level in the center of each of three equal sections of the enclosure (front, rear, and center).

e. Measure and record with a suitable hygrometer, the relative humidity at the locations specified in d above.

f. Repeat the above procedures with heating equipment off and air conditioning equipment on.

NOTE: The above procedures should be repeated to cover the full range of thermostatic settings.

6.2.1.3.2 Stratification

a. Perform procedures a through c in the preceding section.
b. Measure and record the dry-bulb temperatures at the lower-level, mid-level and upper level in the center of each of three equal sections of the enclosure (front, rear and center).

NOTE: The lower level and upper level are levels equal to 10% of the enclosure height from floor and ceiling.

c. Repeat the above procedures during an air conditioning cycle.

NOTE: The above procedures should be repeated to cover the full range of thermo static settings.

6.2.2 System Tests

6.2.2.1 System Physical Characteristics Test

Inspections and tests shall be made in a manner which will provide "yes", "no" or qualified answers to the questions contained in the questionnaire which follows:

SYSTEM PHYSICAL CHARACTERISTICS QUESTIONNAIRE

a. Is the ducting for ventilating, cooling, and heating arranged so that a common system of discharge and return ducts can be properly utilized for all three purposes?

Yes ( ) No ( ) Comment:_____

b. Is the ducting arranged to furnish proper air distribution within each personnel compartment with respect to the number of operating personnel within the compartment? (Ref: Appendix B, System Operation)

Yes ( ) No ( ) Comment: _____

c. Are all controls of the system easily accessible?

Yes ( ) No ( ) Comment: _____

d. Are controls clearly marked to show the appropriate settings for the different modes of operation?

Yes ( ) No ( ) Comment: _____

e. Do operating instructions contain details of the proper settings required to provide the ambient air conditions desired?

Yes ( ) No ( ) Comment: _____

f. Is the electronics cooling air system designed so that air may be taken from outside the shelter or van and exhausted to the outside in order to reduce the temperature rise in the personnel space during summer operation?

Yes ( ) No ( ) Comment:_____

g. Can electronic equipment cooling air be taken from the inside of the shelter or van and exhausted to the inside to facilitate rapid warm-up for winter operation and to utilize the heat liberated from the equipment to heat the personnel space?

Yes ( ) No ( ) Comment:_____

h. Can a portion of the electronic equipment cooling air be recirculated to help control relative humidity in the personnel space during periods of high ambient humidity?

Yes ( ) No ( ) Comment:_____

i. Are all air distribution systems provided with sufficient filters, collectors, or other protective devices to remove dust particles detrimental to equipment and operating personnel? (Ref: Appendix B, System Operation)

Yes ( ) No ( ) Comment:_____

j. Are filters and collectors of permanent and washable type and easily accessible for cleaning, and are cleaning instructions provided?

Yes ( ) No ( ) Comment:_____

k. Do filtering materials show evidence of being corrosive or liberate substances into the enclosure?

Yes ( ) No ( ) Comment:_____

l. Are liquid fuel or gas burning heaters provided with self-contained air intake and exhaust systems so that heaters do not consume oxygen from the personnel space and the products of combustion are exhausted to the outside of the shelter or van?

Yes ( ) No ( ) Comment:_____

m. Are ventilating intake and exhaust ports sufficiently separated to minimize the possibility of contamination of the fresh air supply? (Ref: Appendix B, System Operation).

Yes ( ) No ( ) Comment:_____

n. Are positive closures provided at all exterior openings for protection against wind blown dust, snow, and water?

Yes ( ) No ( ) Comment:_____

o. Is a port provided for connection of a chemical corps collective protector?

Yes ( ) No ( ) Comment:_____

6.2.2.2 System Noise Test

a. Close all doors, windows, vents or other openings of the enclosure except vents required to be open for operation.

b. Turn on all electronic and associated equipment within the van or shelter. (Ventilation, heating and air conditioning equipment off).

c. Measure and record the octave-band pressure level at each normal operating position with the octave-band noise analyzer.

d. Repeat measurements and recordings taken in c. above, under the following conditions:

1) A ventilation cycle with all electronic and associated equipment operating.
2) A heating cycle with all electronic and associated equipment operating.
3) An air conditioning cycle with all electronic and associated equipment operating.
4) A combined heating, ventilation, and air conditioning cycle with all electronic and associated equipment not operating.

NOTE: All tests should be made with equipment operating in the noisest mode.

6.2.2.3 System Environmental Extremes

6.2.2.3.1 Low Temperature Test

a. With shelter or van doors, windows, and vents closed, expose the assemblage to an ambient temperature of -65°F for a period of 12 hours or to practical thermal equilibrium, whichever occurs first. (Practical thermal equilibrium is attained when the temperature of a part of the test item having the largest thermal mass changes less than 1°F during a half hour period while the ambient temperature remains steady.)

b. Increase the ambient temperature to -50°F and continue to expose for six hours or to practical thermal equilibrium, whichever occurs first. Maintain an ambient temperature of -50°F.

c. With pre-installed thermocouples connected to a recorder, start a continuous recording of temperatures at the mid-level center point of three equal sections of the enclosure (front, center,and rear). Initiate operation of the heating and ventilating system. After a 30 minute period initiate operation of the installed electronic equipment. After one hour shut off the electronic equipment and continue operation of the heating and ventilation system until the average temperature of the enclosure reaches +77°F or the highest temperature attainable, whichever occurs first. The time required to reach this condition shall be noted. After stabilization of this condition for a period of not less

than one hour, perform the procedures of paragraph 6.2.1.2 and 6.2.1.3 to determine the total fresh air volume, mass air velocity, effective temperature and temperature stratification.

NOTE 1: Electronics equipment is required to be operated for a one hour period during this test in that during normal operation this equipment would tend to aid the temperature stabilization.

NOTE 2: In this test, the procedures of 6.2.1.2 & 6.2.1.3 should be performed during a heating cycle and an air conditioning cycle.

6.2.2.3.2 High Temperature Test

a. With the shelter or van doors, windows, and vents open, expose the assemblage to an ambient temperature of +120°F for four hours. With all shelter or van doors, windows, and vents closed, raise the ambient temperature to +120°F plus the effect of 360 BTU/ft^2/hr., of solar heat.

b. After a period of one hour, open all doors, windows, and vents and operate the electronic equipment ventilation system. After 30 minutes initiate operation of the electronic equipment.

c. After one hour, and while continuing operation of the electronic equipment and the electronic equipment ventilating system and maintaining an ambient temperature of +120°F plus the effect of 360 BTU/ft^2/hr of solar heat initiate operation of the shelter or van air conditioning system and close all doors, windows, and vents except those required to be open for the mode of operation. Maintain this condition throughout the tests which follow.

d. With preinstalled thermocouples connected to a recorder, start a continuous recording of temperatures at the mid-level center point of three equal sections of the enclosure (front, center, and rear). Continue this operational condition until the average temperature of the enclosure reaches +73°F or the lowest temperature attainable, whichever occurs first. The time required to reach this condition shall be noted. After stabilization of this condition for a period of not less than one hour, perform the procedures of paragraphs 6.2.1.2 and 6.2.1.3 to determine the total fresh air volume, mass air velocity, relative humidity, effective temperature and temperature stratification.

NOTE: When performing the procedures of 6.2.1.2 and 6.2.1.3 in the above test, a heating cycle and an air conditional cycle should be conducted.

6.3 TEST DATA

6.3.1 Equipment Tests

6.3.1.1 Lighting Equipment Tests

6.3.1.1.1 General Lighting

a. Record the location of all luminaires provided for general lighting.
b. Record all foot-candle measurements of all general lighting at a height of 30 inches above the floor at all intersecting points of the prepared grid.
c. Record all foot-candle measurements of the general illumination level at 3 to 6 inch intervals at all regular work position surfaces on scaled grid patterns representative of the work surface area.
d. Record foot-candle measurements made of general lighting in obscure areas and at equipment surfaces where occasional work is performed.

6.3.1.1.2 Supplementary Lighting

a. Record foot-candle measurements of all general and supplementary illumination at 3 to 6 inch intervals at the surfaces of all work positions equipped with supplemental lighting.
b. Repeat recordings in a above with all electronics ventilating and heating air conditioning system equipment in operation.

6.3.1.1.3 Surrounding Reflectance and Brightness

a. Record foot candle readings in the directions of all work surfaces within the normal fields of vision of the occupant when performing his tasks.
b. Record foot-candle readings 90° laterally and 30° vertically of normal eye positions of the occupants.

6.3.1.1.4 Glare

a. Record positions all noticed areas of glare, both direct and specular, observed from all work positions, positions where occasional inspections, tests and adjustments are made and from randomly selected points within the enclosure.
b. Record foot-candle measurements of observed glare at points specified in a above.

6.3.1.1.5 Shadow

Record the position of all objectionable shadows observed within the enclosure.

6.3.1.1.6 Brightness Contrast

a. Record all negative comments and observations of test personnel concerning the visibility of equipment features requiring reading, manipulation adjustment, and routine maintenance.
b. Record positions about which negative comments and observations were referred.

6.3.1.1.7 Natural Lighting

a. Record observations and comments concerning undesirable effects of natural lighting.

b. Record foot-candle measurements of illumination within the enclosure as a result of natural lighting.

6.3.1.1.8 Light Tightness

Record positions of all points at which light escapes the enclosure after the enclosure has been blacked out.

6.3.1.2 Ventilation Equipment

6.3.1.2.1 Air Velocity at Outlets

Record air velocity in feet per minute at each ventilation duct or outlet within the enclosure.

6.3.1.2.2 Air Movement

Record air velocity in feet per minute at mid level grid points with intervals of one to two feet within the enclosure.

6.3.1.2.3 Air Exhaust

a. Record the smoke concentration within the enclosure prior to turning on the ventilation system.
b. Record the time of energizing the ventilation system.
c. Record the smoke concentration within the enclosure at 30 second intervals for a period of ten minutes, or until an acceptable level has been reached, whichever occurs first.
d. Record total time during which measurement occurred.

6.3.1.3 Heating and Airconditioning Equipment

6.3.1.3.1 Temperature and Humidity

a. Record thermostat setting and time heating equipment is turned on.
b. Record time at which temperature stabilization occurs.
c. Record dry bulb and wet bulb temperatures as measured.
d. Record measured relative humidity.
e. Repeat recordings made in a through d above for the air conditioning cycle.

6.3.1.3.2 Stratification

a. Record dry bulb temperatures at the lower level, mid-level and upper level in the center of 3 equal sections of the enclosure during a heading cycle.
b. Repeat above recordings during an air conditioning cycle.

6.3.2 System Tests

6.3.2.1 System Characteristics Test

Record all answers and comments to questions contained in section 6.2.2.1.

6.3.2.2 System Noise Tests

Record the octave band pressure levels as measured is section 6.2.2.2 under conditions as stated.

6.3.2.3 System Environmental Extremes

6.3.2.3.1 Low Temperature Test

Record data as in 6.3.1.2 and 6.3.1.3 while the enclosure is subjected to low temperatures.

6.3.2.3.2 High Temperature Test

Record data as in 6.3.1.2 and 6.3.1.3 while the enclosure is subjected to high temperatures.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Equipment Tests

6.4.1.1 Lighting Equipment Tests

6.4.1.1.1 General Lighting

Compare illumination measurements of the general lighting (foot candle recordings), within the enclosure of the level of illumination required or prescribed for the various sections of the shelter or van and determine if acceptable.

6.4.1.1.2 Supplementary

Compare illumination measurements of the general and supplementary lighting (foot candle recordings) within the enclosure, to the level of illumination prescribed or required for the position at which measurements were taken and determine if acceptable.

6.4.1.1.3 Surrounding Reflectance and Brightness

Compare illumination measurements recorded in 6.3.1.1.3 with prescribed or required illumination levels for work surfaces including reflection and brightness, and determine if acceptable.

6.4.1.1.4 Glare

Compare foot-candle measurements of glare and comments with prescribed glare conditions and determine if glare is within acceptable limits.

6.4.1.1.5 Shadow

From data pertaining to shadows within the enclosure, recorded in 6.3.1.1.5, determine if shadows are objectionable or within acceptable limits.

6.4.1.1.6 Brightness Contrast

Determine from comments and observations recorded in 6.3.1.1.6, if equipment features are visible and if visibility is within acceptable limits.

6.4.1.1.7 Natural Lighting

Determine from Data record in 6.3.1.1.7, if illumination levels under natural lighting conditions are acceptable.

6.4.1.1.8 Light Tightness

Compare data recorded in 6.3.1.1.8 with data prescribed regarding light tightness under blackout conditions and determine if acceptable.

6.4.1.2 Ventilation Equipment

6.4.1.2.1 Air Velocity at Outlets

a. Average the velocity measurements taken at each outlet as air velocity in feet per minute.
b. Compare average air velocity measurements at each outlet to prescribed velocities and determine if within acceptable limits.
c. Compute from velocity data, the total volume of air supplied to each outlet. (Volume for each outlet equals average velocity multiplied by free area of outlet in square feet).
d. Compare computed values of air volume for each outlet with prescribed air volume for each outlet and determine if within acceptable limits.

6.4.1.2.2 Air Movement

a. Average velocity readings taken in each of 3 equal sections of the enclosure (front, center, and rear)
b. Compare averaged velocity readings with prescribed values for each sections and determine if acceptable.

6.4.1.2.3 Air Exhaust

a. Compute the length of time for exhaust of fumes to occur, and compare with the prescribed time and determine if acceptable.
b. Compare smoke concentration at the end of ten minutes with specified acceptable levels and determine if within acceptable limits.

6.4.1.3 Heating And Air Conditioning Equipment

6.4.1.3.1 Temperature and Humidity

a. Determine from average mass air velocity, average dry bulb and wet bulb temperatures as recorded in 6.3.1.3.1, and the effective temperature chart, Figure B-1, the overall effective temperature (see Appendix B, Figure B-1 in this connection).

b. Compute the length of time for temperature stabilization to occur.

c. Compare determined and computed values of a & b with system prescribed values and determine if within acceptable limits.

6.4.1.3.2 Stratification

Compare averaged dry bulb temperatures recorded in 6.3.1.3.2 with prescribed values and determine if acceptable for each level.

6.4.2 System Tests

6.4.2.1 System Characteristics Test

Compare answers and comments to questions, recorded in 6.3.2.1 to specified values and determine if acceptable.

6.4.2.2 System Noise Test

Compare octave band pressure levels as measured and recorded, with levels prescribed and determine if within acceptable limits.

6.4.2.3 System Environmental Test

Reduce and present data recorded in 6.3.2.3.1 as prescribed in 6.4.1.2 and 6.4.1.3 for low temperature environments.

6.4.2.3.1 Low Temperature Test

Reduce and present data recorded in 6.3.2.3.1 as prescribed in 6.4.1.2 and 6.4.1.3 for low temperature environments.

6.4.2.3.2 High Temperature Test

Reduce and present data recorded in 6.3.2.3.2 as prescribed in 6.4.1.2 and 6.4.1.3 for high temperature environments.

APPENDIX A

WORKSPACE ILLUMINATION

GENERAL

The type of equipment assemblages installed in shelters and vans and the visual requirements for operation and maintenance of the equipment dictate the illumination requirements. It is unlikely that a single standardized and inflexible lighting system would be satisfactory for all installations. The purpose of this discussion is to provide brief general guidance for the evaluation of artificial lighting furnished with the installation under test.

LIGHT DISTRIBUTION

There are three general methods of light distribution which may be used separately or in combination to provide proper illumination. These methods, as illustrated in Figure A-1, are:

a. DIRECT LIGHT. In this method the light from the source falls directly on the task area. This method provides maximum light at the work surface (90 to 100 percent of the output of the luminaire). The disadvantages of direct lighting are glare, shadows, and undesirable brightness contrasts.

b. INDIRECT LIGHT. With indirect lighting, most of the light is reflected from ceiling and walls before reaching the task area. When indirect lighting is arranged so that 90% or more of the light from a shielded source is reflected upward toward the ceiling and upper walls the light will be reflected fairly evenly about the room. This type of lighting is relatively free from shadows and glare, and for many tasks is less fatiguing than direct light.

c. DIFFUSED LIGHT. Diffused lighting, such as that from a source covered by a frosted bowl, is more efficient than indirect light in terms of light per unit of power, but does cause some shadows and glare. Fluorescent lights equipped with baffels provide a diffused and relatively glare free light.

GLARE

Viewer discomfort and reduced visibility for objects in the field of view will occur when a bright source of light appears within the visual field. This effect is referred to as direct glare. Bright reflecting surfaces within the visual field cause specular glare. Glare at any work position should not exceed a factor of 1 - 10 with respect to the illumination level of the work place. Direct glare can be reduced or eliminated by one or more of the following methods:

a. Hoods, visors, and shields to keep direct light from the source out of the viewer's eyes.
b. Use of indirect lighting
c. Avoidance of bright light sources within 60 degrees of the center of the visual field.
d. Distributing the light by use of several low intensity sources in preference to one high intensity source.

Specular glare may be reduced with the following methods:

a. Arrange work spaces and direct light sources so that the angle of incidence from the source does not equal the viewing angle in the work area.
b. Use of diffuse lighting
c. Use dull, mat surfaces and avoid polished surfaces.

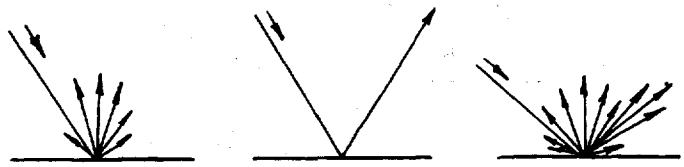
SURROUND BRIGHTNESS

A sole source of illumination should not fall exclusively on a task area. There should be some illumination of surrounding areas, but the surround brightness should be at least 10% less than that of the visual task area. The reflectance factors of the adjacent surround surfaces should be no higher than those of objects within the central field of vision (60 degrees).

REFLECTANCE

The reflectance of light falling on a surface is of three kinds as follows (see Figure A-2):

a. SPECULAR. Specular reflection occurs when the light falling on a polished surface is reflected at an angle equal to the angle of incidence.
b. DIFFUSE. Diffuse reflection occurs when the incident light is reflected from a surface composed of rough irregular particles.
c. COMPOUND. Compound reflection is the reflection from surfaces having both diffuse and specular reflecting characteristics. Most surfaces are compound reflectors.



Mat surface (Diffuse) | Polished surface (Specular) | Semi-gloss surface (Compound)

FIGURE A-2. Light Reflection

SURROUND REFLECTANCE

The reflectance of floors, ceilings, walls, furnishings and equipment affects the general illumination level and quality, and must be carefully evaluated in planning the general illumination. Work areas with highly reflecting surfaces require less light than those with low reflecting surfaces. However, highly reflecting surfaces used to enhance general illumination should be free of specular glare and should be used with caution when such surfaces fall within the normal task area visual field. Desk tops and equipment work stations should not have polished surfaces. Reflectance factors suitable for application in shelters and vans are illustrated in Figure A-3. These factors can be used as general guidance and may be modified by requirements of the particular installation.

SHADOW AND COLOR

The use of diffused light whenever possible will eliminate or reduce shadows. Light colors in obscure areas will improve the illumination of these areas through interreflections from the surfaces. The various colors have different reflectance factors and should be selected to enhance the general illumination as well as for esthetic reasons. Dark shades should not be used on large surfaces if avoidable; pastels and light shades are recommended. Table A-1 shows the approximate reflectance factors of the various colors.

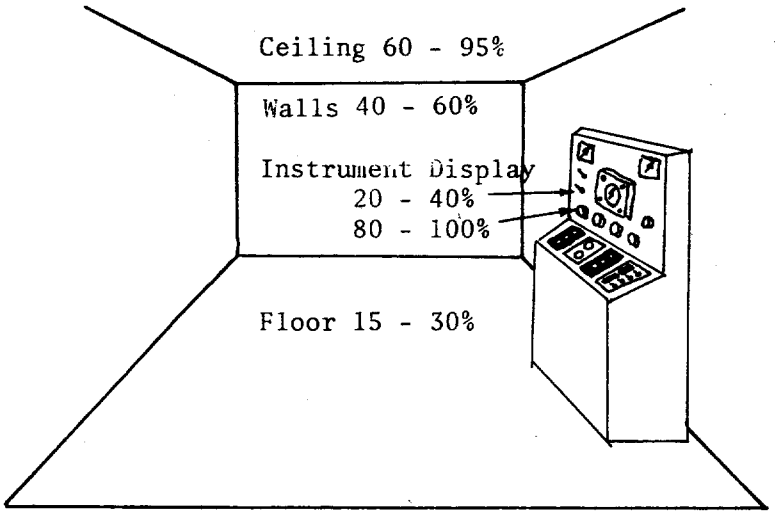


FIGURE A-3. Typical Recommended Reflectance Factors for Room Surfaces

ILLUMINATION LEVELS

Illumination levels recommended for general and supplementary lighting under various task conditions are listed in Table A-II. Supplementary lighting, when required, should preferably be designed to permit adjustment of the light position in order to avoid glare and shadows on the work surface.

TABLE A-I

APPROXIMATE REFLECTANCE FACTORS OF SURFACE COLORS

Color	Amount of reflected light (%)	Color	Amount of reflected light (%)
White	85	Green	
Yellow		Light	65
Light	75	Medium	52
Medium	65	Dark	7
Buff		Blue	
Light	70	Light	55
Medium	63	Medium	35
Gray		Dark	8
Light	75	Red	
Medium	55	Dark	13
Dark	30	Brown	
		Dark	10

MEASUREMENT OF ILLUMINATION

a. GENERAL CONSIDERATIONS. The design of proper and adequate illumination involves many factors other than the intensity or level of illumination, which is ordinarily measured in terms of foot-candles. Perhaps the most important of these factors is bright ess which, simply stated, is the luminous intensity or reflecting characteristics of a surface. Other important considerations include uniformity, contrast, and glare.

The foot-candle meter used for measurement of illumination may be compared to the thermometer used for measurement of heat. Neither instrument indicates fully the overall quality and adequacy of the installation. A comparision shows that the adequacy for efficiency and comfort of personnel depends upon:

HEATING	ILLUMINATION
1. Temperature	1. Foot-candles
2. Humidity	2. Brightness
3. Radiation of surfaces	3. Uniformity (contrast)
4. Air Motion	4. Glare

In each case the measuring instrument measures only a part of the requirements that must be met for a fully adequate installation. It is readily apparent that a meaningful assessment of lighting adequacy must give full consideration to all factors bearing on the problem, as discussed in the preceding paragraphs.

b. MEASUREMENT PROCEDURES. Although no hard-and-fast methods of measurement applicable to all installations can be prescribed, the general procedures and precautions listed below will be useful as guidance for making a lighting survey:

1. If available, use a foot-candle meter which may be placed in any position without impairing the readability of the indicating meter. (An instrument in which the photoelectric cell and the microammeter are separate units is best.)
2. Be sure that the meter is calibrated before use.
3. Carefully follow instructions furnished with the meter.

Application of correction factors may be required for different types of lighting and for angle of incidence of indirect and diffused light.

4. Place the meter as close as possible to the point or surface where the illumination is to be measured. (The illumination is proportional to the intensity of the source and inversely proportional to the square of the distance of the source from the surface.)
5. Take sufficient readings so that additional readings will not change the average readings.

6. Check for shadows and reflections. Do not interfere with light from an important lighting source.

7. Make brightness and visibility surveys at work positions and record subjective personnel reactions.

8. Record data, including notes and comments, on standard forms as the survey progresses.

APPENDIX B

VENTILATION, AIR CONDITIONING AND HEATING

GENERAL

Although the control of environmental air in enclosed areas involves several discrete engineering disciplines, the fundamental interrelationship of the applied engineering techniques requires that a practical approach to determining the adequacy of any one must treat the subject as a whole.

The surrounding conditions which contribute to the operating efficiency of equipment and the safety, efficiency, and comfort of personnel comprise a combination of temperature, humidity, air movement and radiation of surfaces. When radiation effects are minimal, this combination may be expressed as an empirical sensory index known as effective temperature (ET). The effective temperature is determined from dry and wet-bulb thermometer readings and air movement measurements by reference to the Effective Temperature chart of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). See Figure B-1.

Temperature ranges of 66 to 73 ET for summer and 68 to 73 ET for winter are generally accepted as within the comfort range of the majority of people.

For practical purposes, readings obtained with the dry-bulb thermometer are the best indications of warmth under ordinary room conditions with still or slowly moving air. Most normally clothed men engaged in sedentary or slightly active work are thermally comfortable the year around in an environment of 73 to 77°F dry-bulb temperature with a relative humidity range of 25 to 60 percent and air movement of 15 to 25 fpm. Obviously, considerable latitude of variations from these ideal conditions must be allowed for operations in the military environment. In general, any combination of temperature, humidity and air circulation acceptable for the efficiency and comfort of operating personnel will be well within the range satisfactory for operation of most equipment.

SYSTEM OPERATION

Optimum control of the envrionmental air in shelters and vans is realizable when the equipment for ventilating, heating, and cooling is designed to function as an integrated system. A common ducting system should be used for all modes of operation with discharge at floor level and return at ceiling for the heating mode, and discharge at ceiling and return at floor level for cooling. Air circulation should be sufficient to prevent stratification greater than 7°F between high and low extremes. The ventilating system should furnish a minimum of 15 to 20 cfm of fresh air per person, and air movement should be in the range of 15 to 25 fpm. Intake and exhaust ports should be well

separated to prevent contamination of the ventilating air.

The air distribution system should be equipped with filters or collectors to remove dust. The filters or collectors should be easily assessible for cleaning and servicing. All exterior openings should be provided with traps or positive closures for protection from wind blown dust, snow, and water.

When liquid fuel or gas burning heating equipment is used, heaters should be installed in such a manner that the products of combustion are exhausted to the outside of the shelter or van. Positive means should be provided to supply fresh outside air to replace oxygen consumed by heaters.

Air conditioning equipment should include means for controlling relative humidity within the ranges specified by the appropriate document.

The equipment cooling air system should be designed so that air may be taken from the outside of the shelter or van and exhausted to the outside for summer operation. The design should permit air to be taken from inside the shelter or van and exhausted to the inside to facilitate rapid warm-up for winter operation and to utilize the heat liberated from the equipment to heat the personnel space. It should be possible to control the system so that a portion of the electronic equipment cooling air may be recirculated within the personnel space as a means of controlling humidity during periods of high ambient humidity. Controls should be readily accessible and clearly marked to show the appropriate adjustment for the particular ambient environment.

The intelligibility of voice communications and the safety, efficiency and comfort of personnel require that the noise level in the enclosure be controlled within acceptable limits. Noise sources include the sounds and vibrations generated by the operation of the installed equipment or system as well as that inherent in the design of the ventilating, heating, and air conditioning equipment. The reverberant characteristics of the shelter or van and its acoustical treatment (or lack of it) will also have significant effects on the noise level of the interior. The overall acoustical design of the enclosure and installed equipment should be such that operating personnel have no need for earplugs or other passive acoustic devices. Recommended limits of ambient sound pressure levels are contained in Tables B-I and B-II.

MEASUREMENT OF AIR VELOCITY AND VOLUME

There are a number of commonly used instruments for measurement of air velocity and volume movement. These include thermal anemometers, the Kata thermometer, pitot tube, deflecting vane anemometer and propeller or revolving vane anemometers. In addition, airborne solid tracer techniques may be used for measurement of very low air velocities in free space by timing the rate of movement of a smoke puff, feather or piece of lint. Some of the various instruments for measurement of low to moderate air velocity along with the range of application and precision are shown in Table B-III.

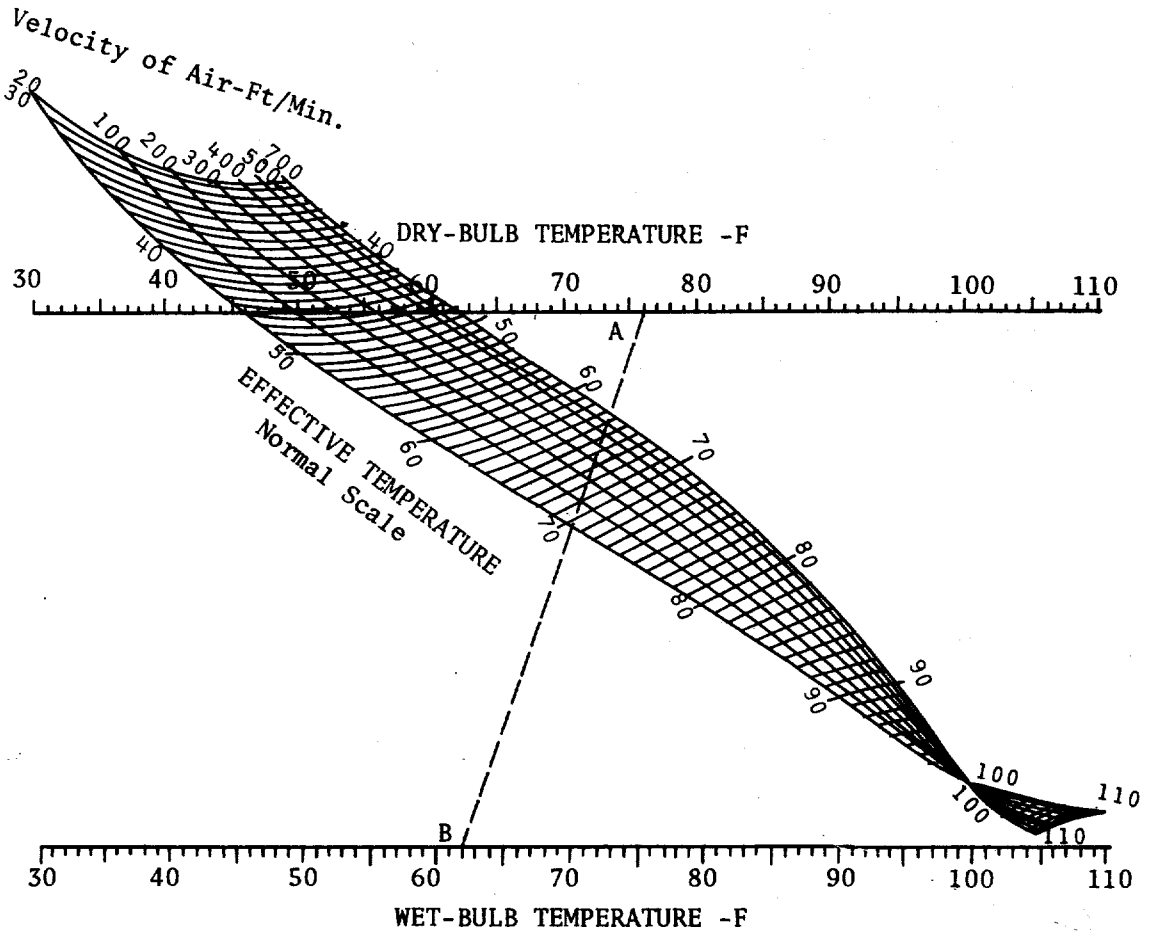


FIGURE B-1. Effective Temperature Chart

The effective temperature, for persons wearing normal indoor clothing and engaged in sedentary or light muscular work, is found on the chart at the point where a line drawn between dry-bulb temperature and wet-bulb temperature (A-B) crosses the air velocity line.

The deflecting van type anemometer appears to be the most suitable instrument for determining the total volume of air supplied in shelters and vans. This type anemometer consists of a pivoted vane enclosed in a case. As air passes through the instrument from an upstream to a downstream opening it exerts pressure on the vane. A damping magnet and a hairspring resist movement of the vane, providing instantaneous readings of directional velocities on an indicating scale. The average velocity obtained from a traverse of the duct outlet with a suitable probe will give the volume of air movement in cubic feet per minute (cfm) when multiplied by the free area of the duct outlet in square feet. It is necessary to make multiple measurements on a traverse of the outlet in order to obtain an average velocity since the velocity is seldom uniform across the opening. The velocity is generally highest near the center and lowest near the corners or edges. The probe should be held one inch away from the face of the grill, where the constriction due to the thin bars has disappeared and the airstream has not yet spread beyond the outlet dimensions. With deflecting grills the probe should be turned to the angle giving the maximum reading.

For measurements at round duct outlets not less than 20 readings should be taken along 2 diameters at centers of equal annular areas as shown in Figure B-2.

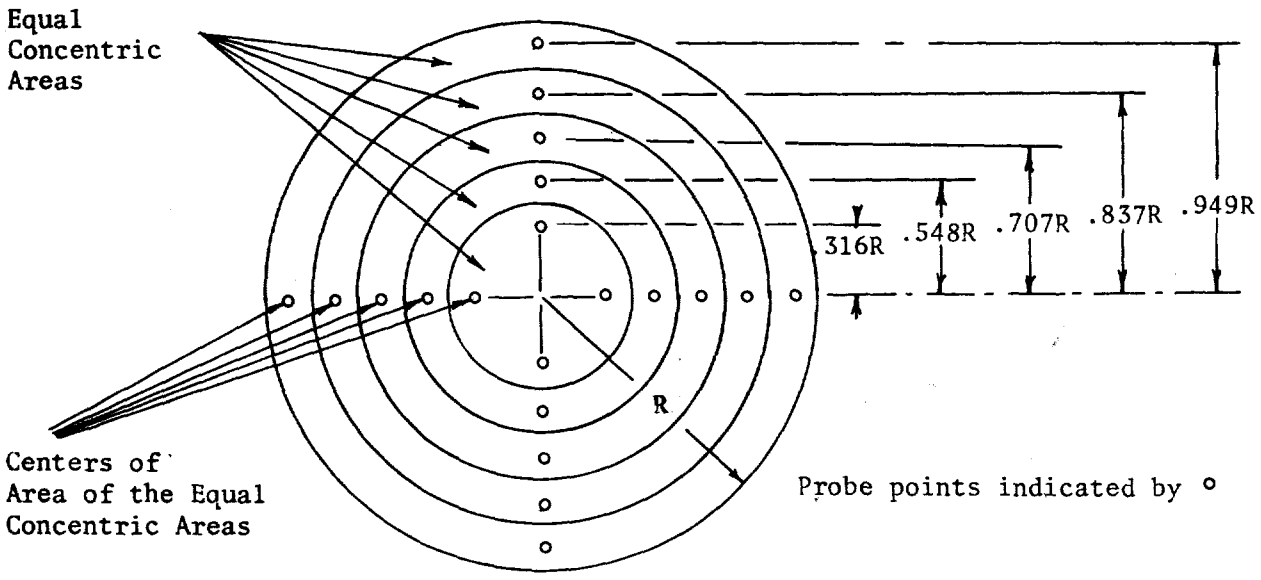


FIGURE B-2. Air Velocity Traverse for Round Ducts

TABLE B-I

RECOMMENDED UPPER LIMITS OF AMBIENT NOISE

Installed Equipment Operating
Ventilators, Air Conditioners, Heaters NOT Operating

Octove Band Frequency Limits (cps)			Sound Pressure Levels (db re 0.0002 microbar)
37.5	-	75	76
75	-	150	69
150	-	300	64
300	-	600	59
600	-	1200	57
1200	-	2400	55
2400	-	4800	53
4800	-	9600	52
9600	-	19200	51

TABLE B-II

RECOMMENDED UPPER LIMITS OF AMBIENT NOISE

Installed Equipment Operating
Ventilators, Air Conditions, Heaters
Operating Alone or in Combination

Octave Band Frequency Limits (cps)			Sound Pressure Levels (db re 0.0002 Microbar)
37.5	-	75	79
75	-	150	73
150	-	300	68
300	-	600	64
600	-	1200	62
1200	-	2400	60
2400	-	4800	58
4800	-	9600	57
9600	-	19200	56

TABLE B-III. AIR VELOCITY MEASUREMENT

Instrument/Method	Application	Range fpm	Precision
Thermal anemometer	Low velocities; directional or nondirectional	5-1000	1-20%
Kata thermometer	Low air velocities in rooms; nondirectional	5-300	5-15%
Deflecting vane anemometer	Air velocities at outlets, in rooms; directional	30-24,000	5%
Revolving vane anemometer	Moderate air velocities in ducts and rooms; somewhat directional	100-2000	5-20%
Venturi type multiplying pitot tube with micromanometer	Low velocities in rooms and ducts; directional	100-2000	1-5%
Smoke puff or airborne solid	Low velocities in rooms; highly directional	5-50	10-20%

For rectangular ducts, a minimum of 16 readings should be taken at the centers of equal areas over the cross section of the duct outlet, as shown in Figure B-3. The number of equal areas should be such that the centers of the areas are not more than two inches apart.

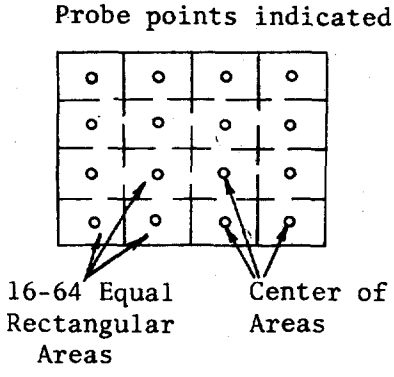


FIGURE B-3.
FIGURE B-3. Air Velocity Traverse for Rectangular Ducts

The deflecting vane anemometer may also be used for measuring the motion of air in a room and in locating objectionable drafts. However, accurate measurement is difficult when the air velocity is very low or the flow pattern is unstable and mass turbulance is of the same order of magnitude as the velocity. In such cases, data useful for calculating average velocity and effective temperature can be obtained with highly sensitive instruments such as the thermal anemometer and Kata thermometer, or use of airborne solid techniques.

The measurement of air flow by timing the movement of smoke puffs or extremely light substances such as lint or feathers, although awkward and time consuming, can provide satisfactory results when more sophisticated instruments are not available. Smoke tubes, smoke candles, and smoke bombs are available for this purpose.

TEMPERATURE MEASUREMENT

The required temperature readings may be made with any good quality properly calibrated mercury or alcohol type thermometer. Thermocouples and resistance type thermometers are also excellent for this application, and either non-recording or recording instruments may be used. When a liquid thermometer is used allow ample time for the thermometer to attain equilibrium with the surrounding air. Read with the eye at the same level as the top of the liquid column to avoid parallax. If considerable radiation from surrounding objects or surfaces is present, shield the instrument by placing highly reflective surfaces between it and the sources of radiation. Do not obstruct

the air movement around the instrument; improper shielding may increase rather than decrease errors.

HUMIDITY MEASUREMENT

The hygrometer is an instrument which measures the humidity of the air. There are several types suitable for use in shelters and vans. The organic hygrometer, which employs human hair, animal membrane or other organic material which changes in dimension with changes in humidity, provides direct indicator readings of relative humidity. The instrument is inexpensive and simple to use, but requires frequent calibration. Hygrometers which employ the dry-bulb and wet-bulb technique are shown as psychrometers. The wet-bulb is covered with a wick or sock. When the wick is wetted with distilled water and ventilated with rapidly moving air the evaporation will cause a lower temperature reading of the wet-bulb thermometer than that of the dry-bulb thermometer. The difference is known as the wet-bulb depression. The aspirated physchrometer is ventilated by a small fan, a syringe, or other source of rapidly moving air. A more common type is the sling physchrometer, which has the two thermometers mounted side by side on a frame with a handle by which the device can be whirled through the air. The relative humidity is determined from charts or tables showing the relation between the two thermometer readings and the humidity. See Table B-IV. A physchrometer suitable for making continuous recordings can be made with two thermocouples, one fitted with a wetting sock and wick connected to a controlled water supply. This type instrument may not be commercially available, but can be fabricated and calibrated in a well equipped laboratory.

NOISE MEASUREMENT

The noises generated within an enclosure by operating equipment comprise a multitude of frequencies. The quality of these sounds and the effect on the human ear vary according to the component frequencies and sound pressure level. For this reason, standard measurements of ambient noise levels are made with an octave band noise analyzer that measures the sound pressure level in frequency bands, usually one octave wide, over the audible range of approximately 20-20,000 cps. The octave band noise analyzer required for the test contained herein must be equipped with an octave band filter set meeting Specification III 10-1953 of the American Standards Association (ASA) or Recommendation ISO/R266-1962 of the International Organization for Standardization (ISO).

TABLE B-IV

RELATIVE HUMIDITY FROM DRY AND WET BULB TEMPERATURES

Dry Bulb Temp., °F	Wet-Bulb Temperature, °F									
	30	31	32	33	34	35	36	37	38	39
	Relative Humidity, Per-Cent									
30	100.0									
31	89.1	100.0								
32	79.2	89.6	100.0							
33	70.4	80.2	90.3	100.0						
34	62.1	71.7	81.3	90.6	100.0					
35	54.4	63.6	72.8	81.7	90.8	100.0				
36	47.1	56.0	64.9	73.5	82.2	91.0	100.0			
37	40.5	49.0	57.5	65.7	74.1	82.6	91.2	100.0		
38	34.2	42.4	50.6	58.5	66.6	74.7	83.0	91.5	100.0	
39	29.1	36.2	44.1	51.7	59.5	67.3	75.3	83.4	91.6	100.0
40	22.9	30.5	38.1	45.4	52.9	60.4	68.1	75.9	83.8	91.9
41	17.9	25.2	32.5	39.5	46.7	53.9	61.3	68.8	76.4	84.2
42	13.2	20.2	27.2	32.8	40.9	47.8	55.0	62.2	69.5	76.9
43		15.6	22.3	28.8	35.4	42.2	49.0	56.0	63.0	70.1
44		11.2	17.7	24.0	30.4	36.8	43.4	50.1	56.9	63.8
45			13.5	19.5	25.7	31.9	38.2	44.7	51.1	57.8
46			9.5	15.3	21.3	27.2	33.3	39.5	45.8	52.2
47				11.4	17.1	22.9	28.8	34.7	40.8	46.9
48					13.3	18.9	24.5	30.3	36.1	42.0
49					9.7	15.1	20.5	26.0	31.6	37.3
50						11.5	16.8	22.1	27.5	33.0
51						8.2	13.3	18.4	23.6	29.0
52							10.1	15.0	20.0	25.1
53							7.0	11.8	16.6	21.6
54								8.8	13.5	18.2
55								6.0	10.5	15.1
56									7.7	12.2
57										9.4
58										6.9

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp., °F	Wet-Bulb Temperature, °F									
	40	41	42	43	44	45	46	47	48	49
	Relative Humidity, Per-Cent									
40	100.0									
41	92.0	100.0								
42	84.5	92.2	100.0							
43	77.4	84.8	92.4	100.0						
44	70.8	77.9	85.2	92.5	100.0					
45	64.5	71.4	78.4	85.5	92.7	100.0				
46	58.7	65.3	72.0	78.8	85.8	92.8	100.0			
47	53.2	59.5	66.0	72.6	79.2	86.0	93.0	100.0		
48	48.0	54.1	60.3	66.7	73.1	79.6	86.3	93.1	100.0	
49	43.1	49.0	55.0	61.1	67.3	73.6	80.1	86.6	93.2	100.0
50	38.6	44.3	50.1	55.9	61.9	68.0	74.2	80.5	86.9	93.4
51	34.3	39.8	45.3	51.0	56.8	62.6	68.6	74.7	80.8	87.1
52	30.3	35.6	40.9	46.4	51.9	57.6	63.3	69.2	75.1	81.2
53	26.5	31.6	36.8	42.1	47.4	52.8	58.4	64.0	69.8	75.5
54	23.0	27.9	32.9	38.0	43.1	48.4	53.7	59.1	64.7	70.3
55	19.7	24.4	29.3	34.1	39.1	44.2	49.3	54.6	59.9	65.3
56	16.6	21.2	25.8	30.5	35.3	40.2	45.1	50.2	55.3	60.6
57	13.7	18.1	22.6	27.1	31.8	36.4	41.2	46.1	51.1	56.1
58	11.0	15.2	19.6	24.0	28.4	32.9	37.6	42.3	47.0	51.9
59	8.5	12.6	16.7	21.0	25.3	29.6	34.1	38.6	43.2	47.9
60	6.1	10.1	14.1	18.2	22.3	26.5	30.8	35.2	39.6	44.2
61		7.7	11.6	15.5	19.5	23.6	27.7	32.0	36.3	40.6
62		5.5	9.3	13.1	16.9	20.8	24.9	28.9	33.1	37.3
63			7.1	10.8	14.5	18.3	22.1	26.1	30.0	34.1
64			5.0	8.6	12.2	15.8	19.6	23.4	27.2	31.2
65				6.6	10.0	13.5	17.2	20.8	24.6	28.4
66				4.6	8.0	11.4	14.9	18.4	22.0	25.7
67					6.1	9.4	12.8	16.2	19.7	23.2
68					4.3	7.5	10.8	14.1	17.4	20.9
69						5.7	8.9	12.1	15.3	18.6
70						4.1	7.1	10.2	13.4	16.6
71							5.5	8.5	11.5	14.6
72							3.9	6.8	9.7	12.7
73								5.3	8.1	11.0
74								3.8	6.6	9.3
75									5.1	7.8
76									3.7	6.4
77										5.0
78										3.7

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp., °F	Wet-Bulb Temperature, °F									
	50	51	52	53	54	55	56	57	58	59
	Relative Humidity, Per-Cent									
50	100.0									
51	93.5	100.0								
52	87.3	93.6	100.0							
53	81.5	87.6	93.7	100.0						
54	76.0	81.8	87.8	93.8	100.0					
55	70.8	76.4	82.2	88.0	93.9	100.0				
56	65.9	71.3	76.8	82.5	88.2	94.0	100.0			
57	61.2	66.5	71.8	77.2	82.8	88.4	94.1	100.0		
58	56.8	61.9	67.0	72.3	77.6	83.1	88.6	94.3	100.0	
59	52.7	57.6	62.5	67.6	72.7	78.0	83.3	88.8	94.3	100.0
60	48.8	53.5	58.3	63.2	68.1	73.2	78.4	83.6	89.0	94.4
61	45.1	49.6	54.2	58.9	63.7	68.6	73.6	78.7	83.9	89.1
62	41.6	46.0	50.4	55.0	59.6	64.3	69.1	74.0	79.0	84.1
63	38.3	42.5	46.8	51.2	55.7	60.2	64.9	69.6	74.4	79.3
64	35.2	39.2	43.4	47.6	51.9	56.3	60.8	65.4	70.1	74.8
65	32.2	36.2	40.2	44.3	48.4	52.7	57.0	61.4	65.9	70.5
66	29.4	33.2	37.1	41.1	45.1	49.2	53.4	57.7	62.0	66.4
67	26.8	30.5	34.2	38.1	41.9	45.9	49.9	54.1	58.3	62.5
68	24.3	27.9	31.5	35.2	39.0	42.8	46.7	50.7	54.7	58.9
69	22.0	25.4	28.9	32.5	36.1	39.8	43.6	47.4	51.4	55.4
70	19.8	23.1	26.5	30.0	33.5	37.0	40.7	44.4	48.2	52.0
71	17.7	20.9	24.2	27.5	30.9	34.4	37.9	41.5	45.2	48.9
72	15.8	18.9	22.0	25.3	28.5	31.9	35.3	38.7	42.3	45.9
73	13.9	16.9	20.0	23.1	26.3	29.5	32.8	36.1	39.6	43.1
74	12.2	15.1	18.0	21.1	24.1	27.2	30.4	33.7	37.0	40.4
75	10.5	13.4	16.2	19.1	22.1	25.1	28.2	31.3	34.5	37.8
76	9.0	11.7	14.5	17.3	20.2	23.1	26.1	29.1	32.2	35.4
77	7.6	10.2	12.9	15.6	18.3	21.2	24.1	27.0	30.0	33.0

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp., °F	Wet-Bulb Temperature, °F									
	50	51	52	53	54	55	56	57	58	59
	Relative Humidity, Per-Cent									
78	6.2	8.7	11.3	14.0	16.6	19.4	22.2	25.0	27.9	30.9
79	4.9	7.4	9.9	12.4	15.0	17.7	20.4	23.1	25.9	28.8
80	3.7	6.1	8.5	11.0	13.5	16.0	18.7	21.3	24.0	26.8
81	2.6	4.9	7.2	9.6	12.0	14.5	17.0	19.6	22.2	24.9
82		3.7	6.0	8.3	10.7	13.1	15.5	18.0	20.6	23.1
83			4.9	7.1	9.4	11.7	14.1	16.5	18.9	21.5
84			3.8	6.0	8.2	10.4	12.7	15.1	17.4	19.9
85			2.8	4.9	7.0	9.2	11.4	13.7	16.0	18.4
86				3.9	5.9	8.0	10.2	12.4	14.6	16.9
87				2.9	4.9	7.0	9.0	11.2	13.3	15.5
88					3.9	5.9	7.9	10.0	12.1	14.2
89					3.0	5.0	6.9	8.9	10.9	13.0
90					2.2	4.0	5.9	7.9	9.8	11.9
91						3.2	5.0	6.9	8.8	10.7
92						2.4	4.2	6.0	7.8	9.7
93							3.3	5.1	6.9	8.7
94							2.6	4.3	6.0	7.8
95							1.8	3.5	5.2	6.9
96								2.8	4.4	6.1
97								2.1	3.6	5.3
98									2.9	4.5
99									2.3	3.8
100									1.7	3.1
101										2.5
102										1.9
103										1.3

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp., °F	Wet-Bulb Temperature °F									
	60	61	62	63	64	65	66	67	68	69
	Relative Humidity, Per-Cent									
60	100.0									
61	94.5	100.0								
62	89.3	94.6	100.0							
63	84.3	89.5	94.7	100.0						
64	79.6	84.6	89.6	94.8	100.0					
65	75.2	80.0	84.8	89.8	94.8	100.0				
66	70.9	75.5	80.2	85.0	89.9	94.9	100.0			
67	66.9	71.4	75.9	80.5	85.3	90.1	95.0	100.0		
68	63.1	67.4	71.8	76.2	80.8	85.5	90.2	95.0	100.0	
69	59.4	63.6	67.8	72.1	76.6	81.1	85.6	90.3	95.1	100.0
70	56.0	60.0	64.1	68.3	72.5	76.9	81.3	85.9	90.5	95.2
71	52.7	56.6	60.5	64.6	68.7	72.9	77.2	81.6	86.0	90.6
72	49.6	53.3	57.1	61.1	65.0	69.1	73.3	77.5	81.8	86.2
73	46.6	50.2	53.9	57.7	61.6	65.5	69.5	73.6	77.8	82.0
74	43.8	47.3	50.9	54.5	58.3	62.1	65.9	69.9	73.9	78.1
75	41.1	44.5	48.0	51.5	55.1	58.8	62.5	66.3	70.3	74.3
76	38.6	41.9	45.2	48.6	52.1	55.7	59.3	63.0	66.8	70.6
77	36.2	39.3	42.6	45.9	49.3	52.7	56.2	59.8	63.4	67.2
78	33.9	36.9	40.1	43.3	46.5	49.9	53.3	56.7	60.3	63.9
79	31.7	34.7	37.7	40.8	43.9	47.2	50.5	53.8	57.2	60.7
80	29.6	32.5	35.4	38.4	41.5	44.6	47.8	51.0	54.3	57.7
81	27.7	30.4	33.3	36.2	39.1	42.2	45.2	48.4	51.6	54.9
82	25.8	28.5	31.2	34.0	36.9	39.8	42.9	45.9	49.0	52.1
83	24.0	26.6	29.3	32.0	34.8	37.6	40.5	43.4	46.5	49.5
84	22.3	24.9	27.4	30.1	32.8	35.5	38.3	41.2	44.1	47.0
85	20.7	23.2	25.7	28.2	30.9	33.5	36.2	39.0	41.8	44.7

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp., °F	Wet-Bulb Temperature, °F									
	60	61	62	63	64	65	66	67	68	69
	Relative Humidity, Per-Cent									
86	19.2	21.6	24.0	26.5	29.0	31.6	34.2	36.9	39.6	42.4
87	17.8	20.1	22.4	24.8	27.3	29.8	32.3	34.9	37.5	40.2
88	16.4	18.6	20.9	23.2	25.6	28.0	30.5	33.0	35.6	38.2
89	15.1	17.3	19.5	21.7	24.0	26.4	28.7	31.2	33.7	36.2
90	13.9	16.0	18.1	20.3	22.5	24.8	27.1	29.4	31.9	34.3
91	12.7	14.8	16.8	18.9	21.1	23.3	25.5	27.8	30.1	32.5
92	11.6	13.6	15.6	17.7	19.7	21.9	24.0	26.2	28.5	30.8
93	10.6	12.5	14.4	16.4	18.4	20.5	22.6	24.7	26.9	29.2
94	9.6	11.4	13.3	15.2	17.2	19.2	21.2	23.3	25.5	27.6
95	8.6	10.4	12.3	14.1	16.0	18.0	20.0	22.0	24.0	26.1
96	7.8	9.5	11.3	13.1	14.9	16.8	18.7	20.7	22.7	24.7
97	6.9	8.6	10.3	12.1	13.9	15.7	17.6	19.5	21.4	23.4
98	6.1	7.7	9.4	11.1	12.9	14.6	16.4	18.3	20.2	22.1
99	5.4	6.9	8.6	10.2	11.9	13.6	15.4	17.2	19.0	20.8
100	4.6	6.2	7.7	9.3	11.0	12.7	14.4	16.1	17.9	19.7
101	4.0	5.4	7.0	8.5	10.1	11.7	13.4	15.1	16.8	18.6
102	3.3	4.8	6.2	7.7	9.3	10.9	12.5	14.1	15.8	17.5
103	2.7	4.1	5.5	7.0	8.5	10.0	11.6	13.2	14.8	16.5
104	2.1	3.5	4.9	6.3	7.8	9.2	10.8	12.3	13.9	15.5
105	1.6	2.9	4.3	5.6	7.1	8.5	10.0	11.5	13.0	14.6
106		2.4	3.7	5.0	6.4	7.8	9.2	10.7	12.1	13.7
107		1.8	3.1	4.4	5.7	7.1	8.5	9.9	11.3	12.8
108		1.3	2.6	3.8	5.1	6.5	7.8	9.2	10.6	12.0
109			2.1	3.3	4.6	5.8	7.1	8.5	9,8	11.2
110			1.6	2.8	4.0	5.3	6.5	7.8	9.1	10.5

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp. °F	Wet-Bulb Temperature, °F									
	70	71	72	73	74	75	76	77	78	79
	Relative Humidity, Per-Cent									
70	100.0									
71	95.2	100.0								
72	90.7	95.3	100.0							
73	86.4	90.8	95.4	100.0						
74	82.3	86.6	91.0	95.4	100.0					
75	78.3	82.5	86.7	91.1	95.5	100.0				
76	74.6	78.6	82.7	86.9	91.2	95.5	100.0			
77	71.0	74.9	78.8	82.9	87.0	91.3	95.6	100.0		
78	67.6	71.3	75.2	79.1	83.1	87.2	91.4	95.7	100.0	
79	64.3	67.9	71.7	75.5	79.3	83.3	87.4	91.5	95.7	100.0
80	61.2	64.7	68.3	72.0	75.7	79.6	83.5	87.5	91.6	95.7
81	58.2	61.6	65.1	68.7	72.3	76.0	79.8	83.7	87.6	91.7
82	55.4	58.7	61.2	65.5	69.0	72.6	76.3	80.0	83.8	87.8
83	52.7	55.9	59.1	62.5	65.9	69.3	72.9	76.5	80.2	84.0
84	50.1	53.2	56.3	59.6	62.9	66.2	69.7	73.2	76.8	80.5
85	47.6	50.6	53.7	56.8	60.0	63.3	66.6	70.0	73.5	77.1
86	45.3	48.2	51.2	54.2	57.3	60.5	63.7	67.0	70.3	73.8
87	43.0	45.8	48.7	51.6	54.6	57.7	60.8	64.0	67.3	70.6
88	40.8	43.6	46.4	49.2	52.1	55.1	58.1	61.2	64.4	67.6
89	38.8	41.4	44.1	46.9	49.7	52.6	55.5	58.5	61.6	64.7
90	36.8	39.4	42.0	44.7	47.4	50.2	53.0	55.9	58.9	61.9
91	35.0	37.4	40.0	42.6	45.2	47.9	50.7	43.5	56.4	59.3
92	33.2	35.6	38.1	40.6	43.1	45.8	48.4	51.2	53.9	56.8
93	31.5	33.8	36.2	38.6	41.1	43.7	46.2	48.5	51.6	54.4
94	29.8	32.1	34.4	36.8	39.2	41.7	44.2	46.7	49.4	52.0
95	28.3	30.5	32.7	35.0	37.4	39.8	42.2	44.7	47.2	49.8
96	26.8	29.0	31.1	33.4	35.6	37.9	40.3	42.7	45.2	47.7
97	25.4	27.5	29.6	31.7	33.9	36.2	38.5	40.8	43.2	45.7
98	24.1	26.1	28.1	30.2	32.3	34.5	36.7	39.0	41.3	43.7
99	22.7	24.7	26.7	28.7	30.8	32.9	35.1	37.3	39.5	41.8
100	21.5	23.4	25.3	27.3	29.3	31.4	33.5	35.6	37.8	40.0
101	20.3	22.2	24.1	26.0	27.9	29.9	31.9	34.0	36.1	38.3
102	19.2	21.0	22.8	24.7	26.6	28.5	30.5	32.5	34.5	36.6
103	18.1	19.9	21.6	23.4	25.3	27.1	29.1	31.0	33.0	35.1
104	17.1	18.8	20.5	22.3	24.0	25.9	27.7	29.6	31.6	33.6
105	16.1	17.8	19.4	21.1	22.9	24.6	26.4	28.3	30.2	32.1
106	15.2	16.8	18.4	20.1	21.7	23.5	25.2	27.0	28.8	30.7
107	14.3	15.8	17.4	19.0	20.6	22.3	24.0	25.8	27.5	29.4
108	13.5	14.9	16.5	18.0	19.6	21.2	22.9	24.6	26.3	28.1
109	12.6	14.1	15.6	17.1	18.6	20.2	21.8	23.5	25.1	26.8
110	11.9	13.3	14.7	16.2	17.7	19.2	20.8	22.4	24.0	25.7

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp. °F	Wet-Bulb Temperature, °F									
	80	81	82	83	84	85	86	87	88	89
	Relative Humidity, Per-Cent									
80	100.0									
81	95.8	100.0								
82	91.8	95.8	100.0							
83	87.9	91.8	95.9	100.0						
84	84.2	88.0	91.9	95.9	100.0					
85	80.7	84.4	88.2	92.1	96.0	100.0				
86	77.3	80.9	84.6	88.3	92.1	96.0	100.0			
87	74.0	77.5	81.1	84.7	88.4	92.2	96.0	100.0		
88	70.9	74.3	77.7	81.2	84.8	88.5	92.2	96.1	100.0	
89	67.9	71.2	74.5	77.9	81.4	84.9	88.5	92.3	96.1	100.0
90	65.0	68.2	71.4	74.8	78.1	81.5	85.0	88.7	92.4	96.2
91	62.3	65.4	68.5	71.7	75.0	78.3	81.7	85.2	88.8	92.5
92	59.7	62.7	65.7	68.8	72.0	75.2	78.5	81.9	85.4	89.0
93	57.2	60.1	63.0	66.0	69.1	72.2	75.4	78.7	82.1	85.5
94	54.8	57.6	60.4	63.4	66.3	69.4	72.5	75.7	78.9	82.3
95	52.5	55.2	58.0	60.8	63.7	66.6	69.6	72.7	75.9	79.2
96	50.3	52.9	55.6	58.4	61.2	64.0	66.9	70.0	73.0	76.2
97	48.2	50.7	53.3	56.0	58.7	61.5	64.3	67.2	70.2	73.3
98	46.1	48.6	51.1	53.7	56.4	59.0	61.8	64.6	67.5	70.5
99	44.2	46.6	49.0	51.5	54.1	56.7	59.4	62.1	64.9	67.8
100	42.3	44.7	47.0	49.5	52.0	54.5	57.1	59.7	62.5	65.3
101	40.5	42.8	45.1	47.4	49.9	52.3	54.8	57.4	60.1	62.8
102	38.8	41.0	43.2	45.5	47.9	50.2	52.7	55.2	57.8	60.4
103	37.2	39.3	41.5	43.7	46.0	48.3	50.6	53.1	55.6	58.1
104	35.6	37.7	39.8	41.9	44.1	46.4	48.7	51.1	53.5	56.0
105	34.1	36.1	38.1	40.2	42.4	44.6	46.8	49.1	51.5	53.9
106	32.6	34.6	36.6	38.6	40.7	42.8	45.0	47.2	49.5	51.8
107	31.2	33.1	35.1	37.0	39.1	41.1	43.2	45.4	47.6	49.9
108	29.9	31.7	33.6	35.5	37.5	39.5	41.5	43.6	45.8	48.0
109	28.6	30.4	32.2	34.1	36.0	37.9	39.9	42.0	44.1	46.2
110	27.4	29.1	30.9	32.7	34.6	36.4	38.4	40.4	42.4	44.5

TABLE B-IV

Relative Humidity from Dry and Wet Bulb Temperatures (continued)

Dry Bulb Temp., °F	Wet-Bulb Temperature, °F									
	90	91	92	93	94	95	96	97	98	99
	Relative Humidity, Per-Cent									
90	100.0									
91	96.2	100.0								
92	92.6	96.3	100.0							
93	89.1	92.6	96.2	100.0						
94	85.7	89.1	92.7	96.3	100.0					
95	82.5	85.8	89.2	92.8	96.4	100.0				
96	79.4	82.6	85.9	89.4	92.8	96.4	100.0			
97	76.4	79.5	82.8	86.1	89.5	92.9	96.4	100.0		
98	73.5	76.6	79.7	82.9	86.2	89.5	92.9	96.4	100.0	
99	70.7	73.7	76.7	79.9	83.0	86.3	89.6	93.0	96.5	100.0
100	68.1	71.0	73.9	77.0	80.0	83.2	86.4	89.7	93.1	96.5
101	65.5	68.3	71.2	74.1	77.1	80.2	83.3	86.5	89.8	93.1
102	63.1	65.8	68.6	71.4	74.3	77.3	80.3	83.4	86.6	89.8
103	60.7	63.4	66.0	68.8	71.6	74.5	77.4	80.4	83.6	86.7
104	58.5	61.0	63.6	66.3	69.1	71.9	74.7	77.6	80.7	83.7
105	56.3	58.8	61.3	63.9	66.6	69.3	72.1	74.9	77.8	80.8
106	54.2	56.6	59.1	61.6	64.2	66.9	69.5	72.3	75.1	78.0
107	52.2	54.5	56.9	59.4	61.9	64.5	67.1	69.7	72.5	75.3
108	50.2	52.5	54.8	57.2	59.7	62.2	64.7	67.3	70.0	72.7
109	48.4	50.6	52.9	55.2	57.5	60.0	62.4	64.9	67.6	70.2
110	46.6	48.7	50.9	53.2	55.5	57.9	60.2	62.7	65.2	67.8

Dry Bulb Temp., °F	Wet-Bulb Temperature, °F									
	100	101	102	103	104	105	106	107	108	109
	Relative Humidity, Per-Cent									
100	100.0									
101	96.5	100.0								
102	93.1	96.5	100.0							
103	89.9	93.2	96.6	100.0						
104	86.8	90.0	93.3	96.6	100.0					
105	83.8	86.9	90.1	93.4	96.6	100.0				
106	80.9	84.0	87.1	90.2	93.4	96.7	100.0			
107	78.2	81.1	84.1	87.1	90.2	93.4	96.7	100.0		
108	75.5	78.3	81.2	84.2	87.2	90.3	93.4	96.7	100.0	
109	72.9	75.7	78.5	81.3	84.3	87.3	90.4	93.5	96.7	100.0
110	70.4	73.1	75.8	78.6	81.5	84.4	87.4	90.4	93.6	96.8

APPENDIX C

TEST DATA SHEET
VENTILATION, AIR CONDITIONING AND HEATING
IN SHELTERS AND VANS

DATE _____ EQUIPMENT TESTED _____ SERIAL No. _____ TYPE SHELTER OR VAN _____ SERIAL No. _____

TEST PERSONNEL _____ TEST EQUIPMENT _____

HOUR	WEATHER CONDITIONS				MODE OF OPN (V,AC,H)	AIR VEL (fpm)	AIR VOL (cfm)	AIR MOVEMENT (fpm)			TEMP-DB MID-LEVEL			TEMP-WB MID-LEVEL			RH MID-LEVEL			ET (AVER ML)	STRATIFICATION-DB TEMP									REMARKS
	TEMP		RH	OTHER				F	C	R	F	C	R	F	C	R	F	C	R		F			C			R			
	DB	WB																			LL	ML	UL	LL	ML	UL	LL	ML	UL	

EXPLANATION OF TERMS:

DB-DRY BULB
WB-WET BULB
RH-RELATIVE HUMIDITY
V-VENTILATION
AC-AIR CONDITIONING
H-HEATING
MID-LEVEL-EQUIDISTANT FROM FLOOR AND CEILING
WEATHER CONDITIONS-OTHER- INDICATE WIND VELOCITY AND DIRECTION, SUNNY, CLOUDY, PARTLY CLOUDY, RAIN, SNOW, ETC.

F - FRONT END OF ENCLOSURE
C - CENTER OF ENCLOSURE
R - REAR END OF ENCLOSURE
ET - EFFECTIVE TEMPERATURE
LL - LOWER LEVEL
ML - MID-LEVEL
UL - UPPER LEVEL

COMMENTS: